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TECHNICAL REPORT
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**QUALITY EVALUATION OF HERBS AND SPICES
IN THE MILITARY FOOD SYSTEM**

Project Reference: O&MA 728012.19

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June 1976

**UNITED STATES ARMY
NATICK RESEARCH and DEVELOPMENT COMMAND
NATICK, MASSACHUSETTS 01760**



**Food Engineering Laboratory
FEL-54**

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The services made an official inquiry into the quality of herbs and spices in the Military supply system at the 12-13 January 1972 Armed Forces Product Evaluation Committee (AFPEC) meeting. As a result of this inquiry, it was recommended that the US Army Natick Research and Development Command (NARADCOM) survey samples of herbs and spices from sixteen Continental United States (CONUS) Military supply locations to determine if they conformed to specification requirements. In addition to testing for specification conformance, NARADCOM used a sensory profile panel to evaluate aromatic strength and tested		

for microbiological flora. Herbs and spices from a leading producer of condiments were used as control samples. Results indicated that many of the herbs and spices being used by the Services were only marginal in quality when compared with their control commercial counterparts.

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PREFACE

The US Army Natick Research and Development Command has received complaints about the quality of herbs and spices in the supply system. However, there is a lack of official documentation, unsatisfactory material reports (UMR's, etc.). Part of the problem is undoubtedly due to the limited use of hermetically sealed containers to package these items. The commercial dredge-top retail container does not offer complete protection against moisture transfer, loss of volatiles, and the like. Compounding this problem, condiments with the exception of ground black pepper are locally procured items, or "Y" coded. Local procurement permits government buying of products of a value up to \$2500.00 as small local purchases without inspection to verify that specification requirements have been met. Since the value of most spices and herbs is solely a function of the volatile and non-volatile flavors and analyses for these characteristics are seldom conducted, it is possible that the Government may be receiving something less than it should. The following study was initiated to explore the above problem and to propose changes to improve this situation. This effort was undertaken under Department of Defense Production Engineering in support of stock fund food and food service items.

The authors acknowledge with thanks the assistance of the following personnel of the US Army Natick Research and Development Command:

1. The Flavor Profile Panel.
2. The Food Acceptance Group, Food Science Laboratory.
3. The Food Chemistry Group, Food Sciences Laboratory.
4. The Food Microbiology Group, Food Sciences Laboratory.

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INTRODUCTION

The Armed Forces Product Evaluation Committee requested that the U.S. Army Natick Research and Development Command perform a quality audit of herbs and spices being supplied to the Military Services. Condiments, with the exception of ground black pepper, are locally purchased items, and aside from occasional Unsatisfactory Material Reports, very little feedback data are available to evaluate their quality in the supply system.

Each Military Service requested four installations to submit 6 samples each of ground cinnamon, ground oregano, ground red pepper, ground mustard, chili powder, dehydrated garlic powder, and whole bay leaves with information on date of pack or date of receipt. These items represent the most widely used herbs and spices. They were sent to Natick R&DC in various commercial containers such as glass bottles, paper bags, cans (both clinched and double seamed), cartons and chip-board boxes. The unit net weights ranged from 3/16 ounce to one pound.

EXPERIMENTAL PROCEDURES

A. Chemical Analyses. The following analyses were performed on the herbs and spices: total ash, acid insoluble ash, volatile oil (expressed as ml/100g), non-volatile ether extract, ASTA color value, and moisture. These methods are described in the Official Analytical Methods of the American Spice Trade Association¹. The specific tests required for each herb or spice are referenced in the appropriate specifications for Chili Powder Seasoning², Onions and Garlic, Dehydrated³, and Spices, Ground and Whole⁴.

B. Scoville Pungency Evaluation. Fifteen samples of cayenne pepper and one sample of red pepper were tested using the Scoville (sensory) Heat Test of Pungency of Capsicum Spices and Oleoresins (ASTA Method 21.0) modified to denote a "presence" or "absence" of heat for each sample. Screened panels were presented a series of 4 dilutions in increasing strength; included in each series was a sample at 45,000 Units (for cayenne pepper) and 31,000 Units (for red pepper). These pungency ratings are the minimum requirements set forth in Federal Specification EE-S-631G⁴. Three out of five judges recording positive responses at the minimum allowable pungency level constituted a "passing" sample. In this way, it was not necessary to determine the precise Scoville Value for each pepper but, to determine only if a pepper conformed to the specification requirements.

An alcoholic extract was made by adding 50 ml of 95% ethyl alcohol to 0.10 gram of ground pepper (Schedule A-Range C of ASTA-Method 21.0) and allowing a 20-24 hour extraction period. The extract was then filtered into a 50 ml volumetric flask and brought back to volume with 95% ethyl alcohol. For testing, the dilutions were prepared using a 5% sucrose solution (50 grams made up to a liter), made one hour prior to testing. The proper amount of alcoholic extract was placed in a 50 ml volumetric flask and diluted to the mark with sucrose solution.

For each test, a series of 4 dilutions as specified in Schedule B-ASTA-Method 21.0 was presented to each subject as follows:

<u>Cayenne Pepper Extract</u>	<u>Sample 1</u>	<u>Sample 2</u>	<u>Sample 3</u>	<u>Sample 4</u>
Scoville Units	Blank	25,000	45,000*	60,000
ml of extract	0.00	1.00ml	0.55ml	0.42ml
ml of sucrose (5% solution)	50ml	49.0ml	49.45ml	49.58ml

*Note: For red pepper, 31,000 Scoville Units was substituted for 45,000 units.

Subjects were presented a 5 ml sample of all 4 dilutions at one time in 1 ounce plastic cups. An unsalted cracker and water were served to panel members to reduce flavor carry-over between tastings.

C. Profile Evaluation (spice strength). The standard profile technique was used to evaluate spice strength⁵. The flavor profile panel members (5-6 members per session) were instructed to report the aroma and flavor impressions and their strengths. These impressions and strengths were then converted to "good", "weak" and "absent". The samples were prepared by dilution to just-recognizable

or threshold value as follows (Room temperature was used in all cases):

Garlic-1:1,000,000 dilution prepared in two steps by adding 1 g to 1000 ml water and letting diluent stand 2 hours. A one (1) ml aliquot of this concentrated solution was diluted further into 1000 ml water and let stand for 2 hours. This represented an aqueous solution of 1 p.p.m. garlic.

Cinnamon-0.05 g/100 g applesauce. One (1) g in 200 ml water. Let stand 2 hours. Dilute 10 ml of this solution with 90 g canned applesauce. Let stand 2 hours.

Oregano-0.01 g/100 ml water. One (1) g in 200 ml water. Let stand 2 hours. Dilute two (2) ml of this solution with 98 ml water. Let stand 2 hours.

Mustard-0.2 g/100 g chicken broth. Add 2 g in 100 ml water. Let stand 2 hours. Dilute 10 ml of this solution with 90 g of chicken broth. Let stand 2 hours.

Red Pepper (cayenne pepper and red pepper).-0.02 g/100 g chicken broth. One (1) g in 100 ml water. Let stand 2 hours. Dilute 2 ml of this solution with 98.0 g chicken broth. Let stand 2 hours.

Bay Leaves-0.02 g/100 ml water. 2 g in 100 ml water. Let stand 4 hours. Dilute one (1) ml of this solution in 100 ml water. Let stand 2 hours.

Chili Powder-0.75 g/100 ml water. 5 g in 100 ml water. Let stand 2 hours. Dilute 1.5 ml of this solution in 100 ml water. Let stand 2 hours.

D. Microbiological Evaluations

Preparation of sample. Ten grams of each spice or herb were weighed into a sterile, tared blender jar and blended for 1 to 2 minutes in 90 ml of sterile phosphate buffered water (SBW)⁶.

Dilutions

All dilutions were made from the initial blend (1:10) by transferring 10 ml into 90 ml Butterfield Phosphate buffer-SBW.⁶⁻⁷ The lowest dilution cultured for any count was 1:100 to avoid possible inhibition of growth due to bactericidal or bacteriostatic properties of some spices^{8,9}. In the case of Clostridium perfringens counts, this dilution was achieved by spreading 0.1 ml of 1:10 dilution on duplicate plates of Shahidi Ferguson Perfringens (SFP) agar.

Inhibition of Bacterial Growth by Spices

To determine whether the spices tested would inhibit bacterial growth, Escherichia coli and Staphylococcus aureus were inoculated in tubes of lauryl sulfate tryptose (LST) broth and trypticase soy broth (TSB) containing 10% sodium chloride (NaCl), respectively, to which was added 1 ml of 1:10 dilution of each spice. Excellent growth of both organisms was achieved in their respective media in less than 24 hours at 35°C, indicating that the spices were not inhibitory at the concentration tested. Subsequent recovery of both organisms by standard methods (described below) was also achieved. To allow a margin of safety, the lowest "in-use" dilution of spices for all counting procedures was set at 1:100.

Media

All media were purchased from Difco Laboratories, Detroit, Michigan.

Aerobic Plate Count

One ml dilutions ranging from 10^{-2} to 10^{-5} were pipetted into duplicate petri plates, poured with plate count agar, and incubated at 35°C for 48 hours.

Yeast and Mold Count

Dilutions prepared for aerobic plate counts were also used for making yeast and mold counts. One ml of each dilution was added to a petri plate and poured with potato dextrose agar (PDA), acidified to pH 3.5. Plates were incubated at 23°C for 5 days before counting.

Coliform and Fecal Coliform Count

Coliforms were estimated by a 3-tube probable number (MPN) determination in lauryl sulfate tryptose (LST) broth by standard methods⁶. Gas producing LST tubes were confirmed in brilliant green lactose bile (2%) broth (BGLB). Fecal coliforms were estimated by transferring growth from positive LST tubes to *Escherichia coli* (EC) broth at 45.5°C for 48 hours⁶. Counts, determined from MPN tables, are presented as 30/g when all tubes at the 1:100 dilution are negative.

Coagulase Positive Staphylococci

Coagulase positive staphylococci were estimated by a modification of the 3-tube MPN procedure by using the same dilutions used for the coliform count. To allow for recovery of injured cells, 1 ml of appropriate dilution was added to 5 ml of TSB and incubated at 35°C for 3 hours. An equal volume of TSB containing 19.5% NaCl was then added to each tube to yield a final salt concentration of 10%^{7,10}. After incubation at 35°C for 48 hours, 0.1 ml of the TSB-NaCl culture was spread on each of two plates of Vogel Johnson agar. Plates were incubated at 35°C and examined after 24 and 48 hours for the presence of smooth black colonies with yellow zones. Two or more typical representative colonies were transferred to brain heart infusion (BHI) tubes and tested for coagulase production according to standard procedures⁶. Counts, determined from MPN tables, are presented as 30/g when all tubes at the 1:100 dilution are negative.

Clostridium perfringens

Clostridium perfringens organisms were counted by spreading 0.1 ml of 1:10 and 1:100 dilutions onto duplicate plates of Shahidi-Ferguson perfringens (SFP) agar¹¹. Plates were overlaid with 10 ml of SFP overlay agar (egg yolk omitted), placed into gas pack anaerobic jars (BBL), and incubated at 35°C for 24 hours. Black colonies surrounded by a zone of precipitate were counted and confirmed in lactose motility (LM) agar. Lactose motility agar was steamed for 10 minutes and cooled immediately prior to use. Inoculated tubes were incubated at 35°C for 24 hours. Non-motile, lactose positive cultures in LM agar, exhibiting typical microscopic morphology, were considered to be *C. Perfringens*¹¹. Counts were presented as 50/g when one colony was confirmed from 0.1 ml of a 1:10 dilution. When no colonies were observed, counts were presented as $<100/\text{g}$.

since the lowest dilution per gram was 1:100.

RESULTS AND DISCUSSION

The results of chemical analysis of herbs and spices are shown in Tables 2 through 8. These tables show the chemical analysis of herbs and spices submitted by four (4) CONUS installations from each of the four Services and industry in comparison with specification requirements.

Table 2 Bay Leaves - Generally, most samples met the specification requirements of EE-S-631G for % total ash, acid insoluble ash and moisture; however, almost 60% of the samples had a volatile oil level less than the specification requirement. This condition may have resulted from the procurement, initially, of low quality products, or products which deteriorated during storage due to improper packaging or both of these factors.

Table 3 Garlic- Specification requirements of JJJ-O-1866 for acid insoluble ash was exceeded by 1/2 of the samples and moisture was exceeded by over 1/3 of the samples. This condition may be due to the same reasons stated for bay leaves. High acid insoluble ash may have been due to contamination with dirt or sand and high moisture content may have been due to a high moisture initially or poor packaging.

Table 4 Ground Cinnamon- Generally, samples met the specification requirements of EE-S-631G except that the % volatile oil was lower in almost 3/4 of the samples. This condition is again similar to that for bay leaves.

Table 5 Oregano- Oregano met the moisture requirement of EE-S-631G; however, % total ash was higher in over a third of the samples, % acid insoluble ash was higher in almost 2/5 of the samples and % volatile oil was lower in over 2/3 of the samples. The greater ash and acid insoluble ash content indicate the product may be heavily contaminated with extraneous materials such as stones, sand, fibers, etc. The lower volatile oil content in the samples is probable due to the same assumptions cited for bay leaves.

Table 6 Chili Powder- Over 3/4 of the chili powder samples met the specification requirements of MIL-C-3394C for % total ash. However, none of the samples met the minimum ASTA color requirement. The ASTA color requirement in the specification is "not less than 70 ASTA extractable color." The requirement for 70 ASTA color may be attained through proper blending of California chili pepper (Anaheim variety of Capsicum annum). A high level of California chili pepper is necessary in order to meet the color requirements, i.e., "bright deep red" for peppers and "reddish brown color" in the finished chili powder. Below 70 ASTA color value means that possible an insufficient quantity of California chili pepper was used in the blend or that the color had deteriorated during storage or both factors were occurring.

Table 7 Mustard, Ground - Generally, 2/3 of the samples met the specification requirements of EE-S-631G for total ash. The product essentially conformed to the specification.

Table 8 Cayenne Pepper, ground - The cayenne pepper is no longer called cayenne but is called red pepper. This change was made through ASTA. Furthermore, the Scoville heat range was revised to incorporate both red pepper and cayenne pepper using 30M to 55M Units as specified in EE-S-631H. The results of Scoville pungency Ratings of red pepper as compared with the control samples submitted by industry sources are shown in Table 8. The Scoville rating and the moisture met the specification requirements of EE-S-631G. EE-S-631G requires 30M Units for red pepper and 45M Units for cayenne pepper and a moisture content of not more than 10.0 percent.

Table 9 Profile Panel Evaluation of Spices and Herbs - The results of the profile panel evaluation of herbs and spices are shown in Table 9. In this evaluation, the individual herbs and spices were compared with control samples submitted by a leading condiment manufacturer. The evaluations of these items are as follows:

Bay Leaves - Out of 15 samples submitted, 10 or 2/3 of the samples were rated weak.

Garlic Powder - Out of 13 samples submitted, 3 or approximately 1/4 of the samples were rated weak.

Cinnamon, Ground - Out of 16 samples of ground cinnamon submitted, 8 or 1/2 of the samples were rated weak.

Oregano Powder - Out of 14 samples of oregano powder, 3 or about 1/4 of the samples were rated weak.

Chili Powder - Out of 16 samples of chili powder, 4 or about 1/4 of the samples were rated weak.

Mustard Powder - Out of 14 samples, 7 or 1/2 were judged as weak.

Red Pepper - Out of 13 samples, 5 were judged as weak and 1 sample had no pepper flavor.

The results of the packaging evaluations are shown in Tables 10-16. The polystyrene cup with poly-friction cap used for bay leaves was thought to be too permeable to the atmosphere and thus unsatisfactory. The slip cover fiberboard carton was found to be an unsatisfactory package, see Tables 10 and 12; however, ground mustard packed in a carton with a slip cover was rated as satisfactory by the profile panels, see Table 15, although the panel reported that the ground mustard had a musty after taste. It is possible that this after-taste may have been absorbed from contaminants of the carton. The glassine lined paper bag folded for closure used in packaging of the bay leaves (Table 10), was found to be satisfactory if the bay leaves are used within a short period of time. This was substantiated by the profile evaluation and per cent volatile oil. It is possible that this type of packaging material may be suitable for a leafy type of product such as bay leaves or oregano where the volatile components are entrapped within the leafy material. The friction top can and dredge top can were found to be borderline packages as shown in Tables 10 through 16. This was substantiated by profile tests. Data for some spices indicate that the friction top can offers a slight advantage. None of these cans were hermetically sealed. The glass bottle with plastic screw cap was found to be adequate as a packaging media, although a few samples were rated

unsatisfactory by profile panels as shown in Tables 10-16. It was noted that the glass bottle with plastic cap appears superior to the dredge top and friction top cans; however, it does not prevent moisture transfer because of the loose fit of its plastic screw cap.

Lastly, the hermetically-sealed can is one of the best barriers possible for herbs and spices, although it requires some sort of reclosure device. It was used as shown in Tables 11, 12, 13, 14, 15, and 16.

Microbiological testing of the herbs and spices was conducted as shown in Tables 17-23. Aerobic plate counts ranged from 100 to 9.1×10^6 per gram depending on which spice was being tested. Yeast and mold counts ranged from 100 to 6.7×10^5 per gram. Coliforms were found in cinnamon, garlic powder, and red pepper. No fecal coliforms were found in any of the spices (30/g lowest dilution). Coagulase positive staphylococci were found in one sample of oregano.

C. perfringens was found in oregano, cinnamon, red pepper, and bay leaves, in a range of 50 to 2850 per gram. Oregano had the highest incidence of C. perfringens.

What is the public health significance of these findings? According to Peppler ¹², aerobic plate counts rarely bear any relation to the safety of the spice. On the other hand high plate counts in spices do not always signify that food spoilage will result from their use since usually only small amounts are used to flavor foods. Notwithstanding, low aerobic plate counts do not assure safety or that food spoilage will not occur. The presence of coliform organisms does not necessarily mean that the spices have been contaminated by pathogens. In this regard many spices reportedly contain natural inhibitors which not only control the development of pathogens in the spice itself but in some instances help control other organisms in foods to which the spice is added. Inhibition; however, was not demonstrated in vitro using E. coli and S. aureus as test microbes. Spices, heavily contaminated with yeast and mold, may release lipases which can substantially reduce the storage life of the product to which they are added.

CONCLUSION

The results of this study indicate that the Services are being supplied herbs and spices sometimes of marginal or poor quality. This may be due to initial "marginal" quality, or to poor packaging, or to a combination of both. If these items continue to be procured on a "local" basis and not inspected, they should be obtained only from reputable sources to insure initial good quality. In order to preserve initial quality, they should be procured in protective packaging, (hermetically sealed containers), along with a polyethylene snap-on-lid for reclosure after opening. Dating of packages would assist inventory control and encourage more rapid turnover. Storage at cool temperatures will help maintain quality, also. Ideally, procurements of sufficiently large quantities on a centralized basis in order to justify adequate inspection and verification testing (as in the can with black pepper) would provide the best solution for assuring that spices and herbs of suitable potency are supplied to the Military Services.

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Table 1. Location of Continental United States Bases
Submitting Samples

Navy Bases

- a. Navy Subsistence Office, Puget Sound, Bremerton, WA
- b. Navy Subsistence Office, Norfolk, VA
- c. Naval Supply Center, San Diego, CA
- d. Naval Construction Battalion, Gulfport, MS

Marine Corps Bases

- e. Marine Corps Base, Camp Pendleton, CA
- f. Marine Corps Base, Camp Lejeune, NC
- g. Marine Corps Air Station, Yuma, AZ
- h. Marine Corps Base, Quantico, VA

Air Force Bases

- i. 62nd Air Base Group (SVF), McChord, AFB, WA
- j. Chanute Air Force Base, IL
- k. Bergstrom Air Force Base, TX
- l. Dover Air Force Base, DE

Army Bases

- m. Fort George Meade, MD
- n. Hq., Fort Sam Houston, TX
- o. Fort Bragg, NC
- p. Fort Ord, CA

Industry

ET-Ethylene treated
NT-Non-ethylene treated

Table 2. Chemical Analyses of Bay Leaves

Samples 1/ 2/	% Total Ash	NC 2/ 18	Acid Insol. Ash	Vol Oil Exp as (ml/100g)	NC	% Moisture	NC
Navy							
a.	3.46		0.11	0.96	X	5.58	
b.	3.21		0.23	1.19		5.49	
c.	3.34		0.14	1.26		5.37	
d.	3.54		0.19	1.32		5.25	
Marines							
e.	3.41		0.17	0.26	X	4.83	
f.	4.26		0.19	0.82	X	5.55	
g.	5.98	X	1.29	1.00		5.01	
Air Force							
i.	9.25	X	2.67	0.91	X	5.58	
j.	3.72		0.25	1.17		7.91	X
k.	3.72		0.28	0.67	X	5.01	
l.	3.77		0.15	0.87	X	5.31	
Army							
m.	4.20		0.23	1.17		5.01	
n.	3.53		0.24	0.80	X	5.21	
o.	5.14	X	1.25	0.57	X	5.31	
p.	4.07		0.27	0.97	X	5.01	
Industry							
ET	3.99		0.17	1.07		4.95	
NT	4.05		0.28	0.90	X	6.70	
Specification requirement	-----	4.50*	-----	-----	1.0**	-----	7.00**
%Nonconformance	-----	18	-----	-----	59	-----	5.9

1/ See Table 1. for location

2/ NC - Nonconforming

* Not more than

** Not less than

Table 3. Chemical Analyses of Garlic Powder

Sample 1/ 2/	% Total Ash	% Acid Insoluble Ash	NC 2/ 3/	% Moisture	NC
Navy					
a.	4.77	0.12	X	4.10	X
b.	3.42	0.05	X	5.97	
c.	2.65	0.00		8.48	X
d.	0.01	0.01		6.46	
Marines 1/ 2/					
e.	2.61	0.00		8.83	X
f.	4.99	0.14	X	3.95	
h.	3.59	0.12	X	6.04	
Air Force 1/ 2/					
k.	2.40	0.01		6.93	X
l.	3.26	0.00		6.83	X
Army 1/ 2/					
m.	3.67	0.07	X	5.71	
n.	3.43	0.01		6.80	X
o.	3.65	0.05	X	5.81	
p.	3.95	0.05	X	5.95	
Industry 1/ 2/					
Control	3.2	0.02		6.12	
Specification requirement			.04*		6.5*
% Nonconformance			50		36

1/ See Table 1.

2/ NC = Nonconforming

* Not more than

Table 4. Chemical Analyses of Ground Cinnamon

Sample 1/ NC	% Total Ash	NC 2/ X	% Acid Insol Ash	NC	Vol Oil Exp as (ml/100g)	NC	% Moisture	NC	Non- Vol Extract
Navy									
a.	4.72		0.31		1.15	X	5.49		3.96
b.	5.10	X	0.98		0.39	X	5.86		1.42
c.	4.34		0.01		0.48	X	6.60		1.73
d.	4.52		0.17		0.92	X	5.63		0.84
Marines									
e.	4.33		0.19		0.48	X	7.72		3.48
f.	4.00		0.62		1.96		5.44		0.94
g.	4.15		0.20		0.38	X	6.46		1.00
h.	3.49		0.08		1.36	X	4.79		0.84
Air Force									
i.	3.21		0.12		1.12	X	7.25		0.98
j.	4.81		0.08		1.18	X	5.49		1.58
k.	4.72		0.09		4.04		5.21		2.39
l.	3.06		0.06		1.11	X	7.95		0.77
Army									
m.	3.78		0.11		3.11		6.70		1.42
n.	2.98		0.02		0.91	X	5.79		0.78
o.	3.49		0.14		1.03	X	5.44		0.85
p.	3.19		0.06		0.68	X	5.69		1.25
Industry									
ET	2.89		0.11		1.62		6.79		0.56
NT	3.00		0.13		1.56		7.16		0.55
Specification requirement	3/	5.0*	2.0*	1.50*	11.0*				
% Nonconformance	---	5	0	72	---				

1/ See Table 1.

2/ NC - Nonconforming

3/ Based on Korintji cinnamon

* Not more than

** Not less than

Table 5. Chemical Analyses of Oregano

Sample 1/ 2/	% Total Ash	NC 2/	% Acid Insol Ash	NC	Vol. Oil (Expressed as ml/100g)	NC	% Moisture	NC
Navy								
a.	8.05		1.98		1.83	X	6.54	
b.	7.44		0.97		3.41		6.18	
c.	24.44	X	17.08	X	1.39	X	5.64	
d.	8.06		0.96		2.81	X	7.32	
Marines								
e.	6.78		1.09		1.62	X	7.32	
f.	11.47	X	5.43	X	1.52	X	6.12	
h.	7.62		1.26		3.13		5.52	
Air Force								
i.	9.25		2.67	X	2.73	X	5.58	
j.	6.34		0.80		1.94	X	6.06	
k.	8.46		0.37		2.23	X	7.86	
l.	7.79		1.20		4.90		7.14	
Army								
m.	19.24	X	12.34	X	1.70	X	5.70	
n.	25.31	X	18.18	X	1.34	X	7.40	
o.	11.23	X	5.09	X	1.76	X	5.82	
Industry								
ET								
NT-control								
Specification requirement	----	9.5*	-----	2.0*	----	3.0**	-----	10.0*
% Nonconformance	----	36	-----	43	----	79	-----	0

1/ See Table 1.
2/ NC = Nonconformance
* Not more than
** Not less than

Table 6. Chemical Analyses of Chili Powder

Sample 1/ Navy	% Total Ash	NC 2/ X	% Moisture	NC	Color (ASTA)	NC
a.	6.71		3.92		30.9	X
b.	12.26	X	5.29		33.6	X
c.	6.48		7.65		58.2	X
d.	14.78	X	7.60		49.3	X
Marines						
e.	7.21		2.11		46.1	X
f.	6.99		3.61		16.4	X
g.	7.20		5.10		26.4	X
h.	9.80		4.42		12.4	X
Air Force						
i.	9.06		6.90		50.9	X
j.	7.30		3.67		66.8	X
k.	10.43		10.26		53.5	X
l.	12.10	X	3.73		60.7	X
Army						
m.	9.87		4.11		13.1	X
n.	14.91	X	6.78		47.7	X
o.	7.60		4.79		38.3	X
p.	7.64		3.86		41.5	X
Industry						
Control	9.85		8.83		53.9	X
Specification						
requirement	----	11.0*	----	12.0*	----	70**
% Nonconformance	----	24	----	0	----	100

1/ See Table 1
2/ NC = Nonconforming
* Not more than
** Not less than

Table 7. Chemical Analyses of Ground Mustard

Sample 1/ 2/	% Total Ash	NC 2/	% Acid Insol. Ash	NC	% Moisture	NC	% Volatile Oil	NC
Navy								
a.	5.82	X	0.28		5.07		0.68	X
b.	3.93		0.20		3.42		0.44	
c.	3.80		0.16		2.95		0.78	X
d.	5.43	X	0.19		4.72		0.61	X
Marines								
e.	3.72		0.16		5.96		0.01	X
f.	5.55	X	0.21		4.54		0.79	X
g.	3.53		0.10		4.13		0.44	
Air Force								
	3.77		0.12		4.13		0.58	
	3.72		0.12		5.43		0.39	X
Army								
	3.78		0.15		3.42		0.71	X
	4.11		0.15		4.84		0.01	X
	5.25	X	0.15		5.55		0.49	
	5.37	X	0.16		4.48		0.46	
Industry								
Control	3.83		0.13		3.01		0.45	
Spec. Req.	----	5.0*	----	0.5*	----	6.0*	----	0.4**
% Nonconform-	----	36	----	0	----	0	----	57
ance								

1/ See Table 1

2/ NC = Nonconforming

* Not more than

** Not less than

Table 8. Moisture Analysis and Scoville Pungency Ratings of Cayenne Pepper 2/

Sample 1/	% Moisture	NC	Scoville Rating	NC
Navy				
a.	7.62		} = 45 M Units	
b.	2.40			
c.	7.33			
d.	6.07			
Marines				
e.	9.08		} = 45 M Units	
f.	3.37			
g.	6.13			
Air Force				
h.	3.01		} = 45 M Units	
i.	2.88			
j.	5.17			
k.	3.13			
Army				
l.	2.52		} = 45 M Units = 45 M Units = 31 M Units	
m.	2.94			
n.	2.52			
Industry				
ET	5.89		} = 45 M Units	
NT	6.61			
Specification requirement 3/		10.0	-----	30 - 45 M Units
% Nonconformance		0	-----	0

1/ See Table 1.

NC = Nonconformance

2/ Red pepper - Red pepper has been adopted as the official nomenclature for cayenne pepper and red pepper by ASTA.

3/ Scoville Heat Units have been revised from a minimum of 30 M Units for red pepper and 45 M Units for Cayenne pepper to a minimum of 30 M Units for both peppers in Federal Specification EE-S-631H. The maximum of 55 M Units for both peppers remains unchanged.

Table 9. Profile Panel Evaluation of Spices and Herbs

Sample	Navy 1/	Marines 1/	Air Force 1/	Army 1/	Industry (Standard)
Bay Leaves	a. G b. G c. G d. Sl.W	e. W f. W g. - h. G	i. W (very) j. W k. W l. W	m. G n. W (very) o. W p. W	ET - Sl.W NT - G
Garlic Powder	a. G b. G c. W d. G	e. W f. G g. Not evaluated h. G	i. - j. - k. G l. G	m. G n. G o. W p. G	G
Cinnamon, Ground	a. G (Clove-like) b. W c. W (clove-like) d. W	e. W (Medicinal, Sl. musty) f. G g. W (Very clove-like) h. G	i. G j. G k. G l. Sl.W (medicinal)	m. G n. W (flat, not cinnamon) o. G p. Sl.W	ET - G
Oregano, Powder	a. G b. G c. W d. G (Slightly weak)	e. G f. G g. - h. G	i. G j. W k. W l. G	m. G (Sl. musty) n. - o. G p. G	ET - G NT - G (Sl. Weak)
Chili Powder	a. G b. W c. Sl.W d. G	e. G f. W g. G h. G	i. G j. G k. G l. G	m. W n. G o. G p. G	NT - G
Mustard, Ground	a. G&W (2 different sources) b. W c. G d. G	e. W (musty) f. G (not clean) g. - h. W	i. W j. - k. - l. W	m. G n. W o. G p. G	
Red pepper	a. W b. G c. G d. W	e. G f. Not evaluated g. - h. W	i. W j. No flavor k. G l. G	m. - n. G o. G p. Sl.W	ET - G NT - G
1/ See Table 1.	G = Good Flavor	W = Weak Flavor	ET = Ethylene Treated	NT - Nonethylene	

Table 10. Quality of Bay Leaves as Related to Chemical Analyses,
Profile Evaluations, and Packaging Media

Sample Packaging Media		Date Packed or Procured	% Vol Oil Exp as (ml/100)	NC	% Moisture	NC	Profile Evalua- tion
1.	Glass - 1/2 oz in 112 x 408 btl w/plastic cap	-	0.69	X	5.01		W
2.	Glass btl w/plastic cap	5/72	0.9	X	6.70		G
3.	Glass btl w/plastic cap	5/72	1.07		4.95		Sl.W
4.	Can - 2 oz in 210 x 402 x 514 with friction top	2/72	1.19		5.49		G
5.	Can - 2 oz in 210 x 402 x 514 with friction top	3/72	1.26		5.37		G
6.	Can - 16 oz in 601 x 904 with friction top	11/71	1.32		5.25		Sl.W
7.	Can - 3/16 oz in 105 x 115 x 304 with plastic top	-	0.91	X	5.19		W (very)
8.	Can - 3/16 oz in 105 x 115 x 304 with plastic friction top	-	0.87	X	5.31		W
9.	Bag - 2 oz in 208 x 508 x 312 glassine lined paper folded over closure	7/71	0.96	X	5.58		G
10.	Bag - 2 oz in 208 x 504 x 306 glassine lined paper folded over closure	11/71	1.0		5.01		G
11.	Bag - 2 oz in 208 x 508 x 308 glassine lined paper folded over closure	-	1.17		5.01		G
12.	Polystyrene cup - 2 oz in 313 x 504 with poly-friction cap	-	0.82	X	5.55		W
13.	Polystyrene cup - 2 oz in 314 x 508 with poly-friction cap	-	0.57	X	5.31		W
14.	Fiberboard carton - 2 oz in 504 x 608 with fiberboard slip cover	8/71	1.03		4.83		W
15.	Fiberboard carton - 2 oz in 310 x 701 with fiberboard slip cover	6/72	0.98	X	5.01		W
16.	Box - 2 oz in 214 x 400 x 508 chipboard	-	1.19		7.91	X	W
17.	Box - 3 oz in 102 x 204 x 500 chipboard with friction top	5/72	0.8	X	5.21		W (very)
Specification requirement		-	----	1.0*	-----	7.0**	

NC = Nonconforming
G = Good flavor
W = Weak flavor
* = Not less than
** = Not more than

Table 11. Quality of Garlic Powder as Related to Chemical Analysis,
Profile Evaluations and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Moisture	NC	Profile Evaluation
1.	Packed in glass btl 2 x 2 x 5 with plastic screw cap	5/72	6.12		G
2.	10 oz glass btl 2-7/8 x 6 with plastic cap	4/72	6.46		G
3.	Glass - 2-3/8 oz packed in jar 1-W/16 x 4-1/2 with plastic screw cap	-	6.93	X	G
4.	Glass - 2-3/8 oz packed in jar 1-5/8 with plastic screw cap	-	6.83	X	G
5.	Glass - 7 1/2 oz packed in btl 2-1/2 x 6-3/8 with plastic screw cap	5/72	6.80	X	G
6.	2 oz packed in hermetically sealed can 202 x 204	1/72	8.48	X	W
7.	2 oz packed in hermetically sealed can 202 x 204	12/71	8.83	X	W
8.	Can - 2 oz dredge type, clinch	2/72	4.1		G
9.	Can - 2 oz dredge type, clinch	1/72	5.97		G
10.	Can - 2 oz dredge type, clinch	-	3.95		G
11.	Can - 2 oz dredge type, clinch	-	6.04		G
12.	Can - 2 oz dredge type, clinch	-	5.71		G
13.	Can - 2 oz dredge type, clinch	-	5.81 (Caked solid)		W
14.	Can - 2 oz dredge type, clinch	10/71	5.95		G
Specification requirement					6.5**

NC = Nonconforming

W = Weak flavor

G = Good flavor

** = Not more than

Table 12. Quality of Cinnamon Powder as Related to Chemical Analyses, Profile Evaluations and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Vol Oil Exp as (ml/100g)	NC	% Moisture	NC	Profile Evaluation
1.	Glass - packed in btl 2 x 2 x 5 with plastic screw cap	5/72	1.62		6.79		G
2.	Glass - packed in btl 2 x 2 x 5 with plastic screw cap	5/72	1.56		7.16		G
3.	Glass - 1-3/4 oz packed in 108 x x 410 btl with plastic cap	----	4.04		5.21		G
4.	Glass - 1-3/4 oz packed in 112 x 312 btl with plastic cap	----	1.11	X	7.95		Sl. W. (medicinal)
5.	Can - 4 oz packed in 210 x 304 hermetically sealed	7/71	0.32	X	6.51		G(Clove like)
6.	Can - 1# packed in 210 x 402 x 513 friction top	8/71	0.48	X	6.60		W(Clove like)
7.	Can - 1# packed in 210 x 402 x 513 friction top	----	1.96		5.44		G
8.	Can - 1# packed in 210 x 402 x 513 friction top	----	1.36	X	4.79		G
9.	Can - 1# packed in 210 x 402 x 513 friction top	----	1.03	X	5.44		G
10.	Can - 1# packed in 210 x 402 x 513 friction top	4/72	0.68	X	5.69		SLW
11.	Can - 3 oz packed in 112 x 208 x 313 dredge top, clinch	5/72	0.91	X	5.79		W (not Cin- namon)
12.	Can - 3 oz packed in 100 x 214 x 312 dredge top, clinch	5/71	0.39	X	5.86		W
13.	Can - 4 oz packed in 104 x 210 x 404 dredge top, clinch	7/71	1.15	X	5.49		G
14.	Can - 4 oz packed in 110 x 214 x 312 dredge top, clinch	----	1.13	X	7.25		G
15.	Can - 4 oz packed in 108 x 210 x 404 dredge top, clinch	----	1.18	X	5.49		G
16.	Can - 3 oz packed in 108 x 210 x 404 dredge top, clinch	----	3.11		6.70		G

Table 12. (Cont'd) Quality of Cinnamon Powder as Related to Chemical Analyses, Profile Evaluation, and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Vol Oil Exp as (ml/100g)	NC	% Moisture	NC	Profile Evaluation
17.	Can - 1# packed in 211 x 402 x 513 dredge top, clinch slip cover	4/71	0.92	X	5.63		W
18.	Carton- 1# packed in 310 x 701, slip cover	3/72	0.48	X	7.72		W(medicinal)
19.	Carton - 1# packed in 310 x 701, slip cover	4/72	0.38	X	6.46		Sl. musty W(very clove- like)
Specification Requirement				1.5*		11.0**	-

G= Good flavor

W= Weak flavor

NC= Nonconforming

*= Not less than

**= Not more than

Table 13. Quality of Oregano Leaf and Powder as Related to Chemical Analyses, Profile Evaluation and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Vol Oil Exp as (ml/100g)	NC	% Moisture	NC	Profile Evalua- tion
1.	Glass - packed in jar 2 x 2 x 5 with plastic cap	5/72	3.20		6.84		G
2.	Glass - packed in jar 2 x 2 x 5 with plastic cap	5/72	2.15	X	8.88		G
3.	Glass - 1-3/4 oz packed in 112 x 408 btl	-----	2.23	X	7.86		W
4.	Glass - 7/16 oz packed in 112 x 312 btl	-----	4.90		7.14		G
5.	Can - 2 Oz pack hermetically sealed 202 x 204	9/71	1.62	X	7.32		G
6.	Can - 1 oz loosely packed in 104 x 205 x 203	-----	2.73	X	5.58		G
7.	Can - 2 oz loosely packed in 105 x 205 x 305 dredge top, clinch	2/72	1.83	X	6.54		G
8.	Can - 2 oz loosely packed in 105 x 205 x 305 dredge top, clinch	3/72	3.41		6.18		G
9.	Can - 2 oz loosely packed in 105 x 205 x 305 dredge top, clinch	4/71	1.39	X	5.64		W
10.	Can - 2 oz loosely packed in 105 x 205 x 305 dredge top, clinch	-----	1.52	X	6.12		G
11.	Can - 2 oz loosely packed in 105 x 205 x 305 dredge top, clinch	-----	3.13		5.52		G
12.	Can - 2 oz packed in 105 x 205 x 305 dredge top, clinch	-----	1.94	X	6.06		W
13.	Can - 2 oz packed in 105 x 205 x 305 dredge top, clinch	-----	1.70	X	5.70		G(Sl. musty) G
14.	Can - 2 oz packed in 105 x 205 x 305 dredge top, clinch	-----	1.34	X	5.40		G
15.	Can - 2 oz packed in 105 x 205 x 305 dredge top, clinch	10/71	1.76	X	5.82		G

Table 13. (Cont'd) Quality of Oregano Leaf and Powder as Related to Chemical Analyses, Profile Evaluation and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Vol Oil Exp as (ml/100g)	NC	Moisture %	Profile Evalua- tion
16.	Can - 10 oz packed in 205 x 405 x 600 dredge top, clinch	11/71	2.81	X	7.32	G(Sl. weak)
Specification Requirements		----	----	3.0*	----	10.0**

W= Weak flavor
G= Good flavor
NC= Nonconforming
*= Not less than
**= Not more than

Table 14. Quality of Chili Powder as Related to Chemical Analysis,
ASTA Color, Profile Evaluations and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Moisture	NC	Color (ASTA)	NC	Profile Evaluation
1.	Glass - packed in btl 2 x 2 x 5 with plastic screw cap	5/72	8.83		47.6	X	G
2.	Glass - 2 1/4 oz packed in 112 x 408 btl with plastic screw cap	----	10.26		43.8	X	G
3.	Can - 4 oz packed in 211 x 303 hermetically sealed	5/70	7.65		51.8	X	SLW
4.	Can - 4 oz packed in 211 x 303 hermetically sealed	7/71	6.03		40.7	X	G
5.	Can - 1 1/2 oz packed in 104 x 205 x 203 friction top can with plastic cap	7/72	3.73		54.3	X	G
6.	Can - 4 oz packed in 110 x 2214 x 312 friction top	----	6.90		47.2	X	G
7.	Can - 4 oz packed in 112 x 208 x 312 friction top	5/72	6.78		41.1	X	G
8.	Can - 1# packed in 210 x 402 x 513 friction top	----	4.79		32.1	X	G
9.	Can - 4 oz packed in 108 x 210 x 404 dredge top, clinch	9/71	3.92		2.42	X	G
10.	Can - 4 oz packed in 108 x 210 x 404 dredge top, clinch	----	3.67		31.8	X	G
11.	Can - 4 oz packed in 108 x 210 x 404 dredge top, clinch	----	3.61		13.2	X	W
12.	Can - 4 oz packed in 112 x 208 x 400 dredge top, clinch	----	4.11		10.3	X	W
13.	Can - 4 oz packed in 108 x 210 x 404 dredge top, clinch	10/71	3.86		35.4	X	G
14.	Can - 4 oz packed in 112 x 208 x 400 dredge top, clinch	3/70	4.42		9.5	X	G

Table 14. (Cont'd) Quality of Chili Powder as Related to Chemical Analysis,
ASTA Color, Profile Evaluations and Packaging Media

Sample	Packaging	Date Packed or Procured	% Moisture	NC	Color (ASTA)	NC	Profile Evalua- tion
15.	Can - 4 oz packed in 110 x 214 x 312 dredge top, clinch	2/72	5.29		25.6	X	W
16.	Can - 16 oz packed in 205 x 405 x 601 dredge top, clinch	3/71	7.65		36.2	X	G
17.	Carton - 1# packed in 309 x 700, slip cover	1/71	5.10		23.2		G
18.	Carton - 1# packed in 309 x 700, slip cover	10/71	2.11		16.4		G
Specification Requirement							70*

W= Weak flavor
G= Good flavor
NC= Nonconforming
*= Not less than

Table 15. Quality of Ground Mustard as Related to Chemical Analyses, Profile Evaluations and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Vol Oil in Mustard	NC	% Moisture	NC	Profile Evaluation
1.	Glass - packed in btl 2 x 2 x 5 with plastic cap	5/72	0.45		3.01		G
2.	Can - 4 oz packed in 210 x 303 hermetically sealed	3/71	0.02	X	5.66		W
3.	Can - 4 oz packed in 210 x 303 hermetically sealed	9/71	0.01	X	5.96		W (mustard musty)
4.	Can - 1 1/8 packed in 104 x 205 x 203 plastic friction top closure	----	0.58		3.78		W
5.	Can - 1 1/8 packed in 104 x 205 x 203 plastic friction top closure	----	0.39	X	5.43		W
6.	Can - 1 1/4 oz packed in 104 x 204 x 212 friction top	----	0.01	X	4.84		W
7.	Can - 4 oz packed in 108 x 210 x 404 dredge top, clinch	9/71	0.68	X	5.07		G
8.	Can - 4 oz packed in 110 x 212 x 311 dredge top, clinch	2/71	0.44		3.42		W
9.	Can - 4 oz packed in 108 x 210 x 404 dredge top, clinch	----	0.79	X	4.54		G(not clean)
10.	Can - 4 oz packed in 112 x 208 x 400 dredge top, clinch	----	0.71	X	3.42		G
11.	Can - 4 oz packed in 104 x 210 x 404 dredge top, clinch	----	0.49		5.55		G
12.	Can - 4 oz packed in 104 x 210 x 404 dredge top, clinch	12/71	0.56		4.48		G
13.	Can - 16 oz packed in 211 x 403 x 513 dredge top, clinch	3/71	0.61	X	4.72		G
14.	Can - 1# packed in 211 x 403 x 513 with dredge top, clinch	11/71	0.44		4.13		W
15.	Carton - 4 oz packed in 309 x 200 carton with slipcover	9/70	0.78	X	2.95		G

Table 15. (Cont'd) Quality of Ground Mustard as Related to Chemical Analyses, Profile Evaluations and Packaging Media

Sample	Packaging	Specification requirement	Date Packed or Procured		% Vol Oil in Mustard		NC	Moisture	NC	Profile Evalua- tion
								0.4**to0.6*		-

G= Good flavor
W= Weak flavor
NC= Nonconforming
*= Not more than
**= Not less than

Table 16. Quality of Red Pepper as Related to Chemical Analysis
Scoville Ratings, Profile Evaluations and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Moisture	NC	Scoville Rating	Profile Evalua- tion
1.	Glass - packed in btl 2 x 2 x 5 with plastic screw cap	5/72	5.79		S(\approx 45M Units)	G
2.	Glass - packed in btl 2 x 2 x 5 with plastic screw cap	5/72	6.61		S(\approx 45M Units)	G
3.	Glass - 1 7/8 oz packed in 112 x 408 btl with plastic screw cap	----	5.17		S(\approx 45M Units)	G
4.	Can - 2 oz packed in 202 x 204 and hermetically sealed	1/71	7.63		S(\approx 45M Units)	W
5.	Can - 2 oz packed in 202 x 204 and hermetically sealed	10/71	7.33		S(\approx 45M Units)	G
6.	Can - 2 oz packed in 202 x 204 and hermetically sealed	-----	9.08		S(\approx 45M Units)	G
7.	Can - 1 1/8 oz packed in 104 x 205 x 203 plastic friction top	-----	3.13		S(\approx 45M Units)	G
8.	Can - 1 1/8 oz packed in 104 x 205 x 203 plastic friction top	-----	3.01		S(\approx 45M Units)	W
9.	Can - 1 1/4 oz packed in 104 x 204 x 212 dredge top, clinch	-----	2.52		S(\approx 31M Units)	G
10.	Can - 2 oz packed in 105 x 206 x 305 dredge top, clinch	3/72	2.40		S(\approx 45M Units)	G
11.	Can - 2 oz packed in 105 x 206 x 305 dredge top, clinch	-----	3.37		S Insufficient sample	
12.	Can - 4 oz packed in 108 x 210 x 404 dredge top, clinch	11/71	6.13		S(\approx 45M Units)	W
13.	Can - 2 oz packed in 105 x 206 x 213 dredge top, clinch	-----	2.94		S(\approx 45M Units)	G

Table 16. Quality of Red Pepper as Related to Chemical Analysis
(CONT'D) Scoville Ratings, Profile Evaluations and Packaging Media

Sample	Packaging Media	Date Packed or Procured	% Moisture	NC	Rating	Profile Evalua- tion
14.	Can - 2 oz packed in 105 x 206 x 213 dredge top, clinch	8/71	2.52		S(=45M Units)	S1.W
15.	Can - 2 oz packed in 105 x 206 x 213 dredge top, clinch	----	2.88		0(no flavor)	
16.	Can - 16 oz packed in 210 x 402 x 513 dredge top, clinch	4/71	6.07		S(= 45M Units)	W
Specification Requirement						
				10*	30-55,000 Units	

G = Good Flavor
W = Weak Flavor
NC = Nonconforming
* = Not more than

Table 17. Microbiology of Processed Spices Used by the Armed Forces

Spice	No. of Samples	Range of Counts/g of Spice				
		APC (Aerobic Plate Count)	Yeast and Molds	Coliforms (MPN)	Fecal Coliforms	Coagulase Positive Staphylococci (MPN)
Bay Leaves	16	100 to 30,000	100 to 670,000	30	30	30
Cayenne Pepper	15	3400 to 9,100,000	100 to 20,000	30 to 2400	30	30
Chili Powder	18	100 to 540,000	100 to 8,000	30	30	30
Cinnamon	18	10,700 to 780,000	100 to 4,600	30 to 230	30	30
Garlic	16	3,700 to 980,000	100 to 500	30 to 230	30	30
Mustard Powder	16	500 to 5300	100 to 2,200	30	30	30
Oregano	15	1200 to 3,600,000	100 to 27,000	30	30	30 to 30

Table 18. Aerobic Plate Count (APC) of Processed Spices Used by the Armed Forces

Spices	No of Samples	Number of Samples Containing (per gram)									
		100 to 1000	1000 to 10,000	10,000 to 50,000	50,000 to 100,000	100,000 to 500,000	500,000 to 1,000,000	1,000,000 to 5,000,000	5,000,000 to 10,000,000	10,000,000 to 50,000,000	50,000,000 to 100,000,000
Bay Leaves	16	1	0	7	8	0	0	0	0	0	0
Cayenne Pepper	15	0	0	1	1	0	3	1	4	5	5
Chili Powder	18	0	6	3	4	2	2	1	0	0	0
Cinnamon	18	0	0	0	9	3	4	2	0	0	0
Garlic	16	0	0	4	2	2	5	3	0	0	0
Mustard Powder	16	1	6	9	0	0	0	0	0	0	0
Oregano	16	0	0	5	4	2	1	2	1	0	0
TOTAL	114	2	12	29	28	9	15	9	5	5	5

Table 19. Yeast and Mold Count of Processed Spices Used by the Armed Forces

Spice	Total of Samples	Number of Samples Containing (per gram)				
		100 to 1,000	100 to 10,000	10,000 to 30,000	30,000	
Bay Leaves	16	7	3	5	0	1
Cayenne Pepper	15	8	2	3	2	0
Chili Powder	18	17	0	1	0	0
Cinnamon	18	3	9	6	0	0
Garlic	16	11	5	0	0	0
Mustard Powder	16	12	3	1	0	0
Oregano	15	2	3	8	2	0
TOTAL	113	60	25	24	4	1

Table 20. Coliform Count of Processed Spices Used by the Armed Forces

Spice	No of Samples	Number of Samples Containing (MPN per gram)			
		30	30 to 100	100 to 230	230
Bay Leaves	16	16	0	0	0
Cayenne Pepper	15	111	3	0	1 ^a
Chili Powder	18	18	0	0	0
Cinnamon	18	14	3	1	0
Garlic	16	14	1	1	0
Mustard Powder	16	16	0	0	0
Oregano	15	15	0	0	0
TOTAL	114	104	7	2	1

^a2400/g

Table 21. *Clorstridium perfringens* Count in Processed Spices Used by the Armed Forces

Spices	No of Samples	Number of Samples containing (per gram)			
		100	100 to 500	500 to 1000	1000 to 3000
Bay Leaves	16	14	2	0	0
Cayenne Pepper	15	13	2	0	0
Chili Powder	18	18	0	0	0
Cinnamon	18	15 ^a	3	0	0
Garlic	16	16	0	0	0
Mustard Powder	16	16	0	0	0
Oregano	15	9 ^a	2	2	2
TOTAL	114	101	9	2	2

^aTwo Samples had 50/g

Table 22. Spices Containing Food Poisoning Bacteria and Coliforms

Spices	No of Samples	C. perfringens	Coagulase Positive Staphylococci	Coliforms
Bay Leaves	16	12	0	0
Cayenne Pepper	15	20	0	27 ^a
Chili Powder	15	0	0	0
Cinnamon	18	28	0	22 ^a
Garlic	16	0	0	19 ^a
Mustard Powder	16	0	0	0
Oregano	15	53	7	0

^aFecal Coliforms were negative (30/g)

Table 23. Food Poisoning Bacteria and Coliforms Found in Different Brands and Spices

Brand	Percentage of Spices Containing							
	Bay Leaves	Cayenne Pepper	Cinnamon	Garlic	Oregano			
	C. perf.*	Coli**	C. perf. Coli.	C. perf. Coli.	C. perf. Coli	C. perf. Coli	C.P.***	Staph.
1	0	0	0	11	0	0	0	0
2	0	0	7	5.5	11	0	7	0
3	6	0	13	11	5.5	0	19	33
4	0	0	--	--	--	--	--	--
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	--	--
7	--	--	--	--	--	--	7	0
8	--	--	--	--	--	--	7	0
9	0	0	7	0	0	0	--	--
10	--	--	--	0	0	--	0	0

*C. perfringens

** Coliforms

-- No sample

*** Coagulase Positive Staphylococci